8.0 TECHNICAL TOPICS

The subtopics in sections 8.1 through 8.5 are from the National Oceanic and Atmospheric Administration (NOAA). Approximately 12 awards will be made on these subtopics.

8.1 NOAA TOPIC: ATMOSPHERIC AND HYDROLOGICAL SCIENCES

8.1.1A SUBTOPIC: Microwave Remote Sensing of the Ocean Surface Wind Vector Using Passive Polarimetry

Investigators over the last several years have shown that it is possible to measure the ocean surface wind vector using a polarimetric microwave radiometer system. The ocean surface wind vector is an important environmental parameter for research and operational marine forecasting. A compact system is sought to deploy on the NOAA WP-3D aircraft during hurricane reconnaissance flights and other flights of opportunity. Since other instrumentation typically occupies all the downward looking ports along the aircraft fuselage, integration into a modified WP-3D fuel pod is necessary. Modification of the pod would include any necessary radome and mounting structures for the radiometer system. The polarimetric microwave radiometer should be capable of scanning at least +/-70 degrees off of the aircraft heading at a fixed incidence angle between 45 to 65 degrees from nadir. The radiometer system will have to account for atmospheric effects such as water vapor and precipitation for wind retrievals in the desired range of 0-70 meters/second. A wind speed and direction retrieval accuracy of +/-2 meters/second and +/-20 degrees is required. A spatial resolution on the ocean surface of approximately 1.5 km at an altitude of 6,000m (about 20,000 feet) is desired at an incidence angle of 55 degrees. The ability to report the winds in real-time should also be considered in the system design to allow the relaying of information to hurricane forecasters during hurricane reconnaissance flights. A quantitative measure of rain rate is also desired. The entire system should be as compact and self-contained as possible to minimize potential interference with other equipment. Existing wiring in the aircraft wing should be utilized for necessary interfacing between the pod and the main cabin.

8.1.2A SUBTOPIC: Site Specific Analysis and Display of Tornado Hazard Potential

The NWS maintains a data base containing track characteristics and intensity data for tornados over the contiguous United States since 1950. These data have been used to estimate the tornado hazard at various points across the country. Such estimates have a wide variety of engineering, architectural, actuarial, and regulatory applications. To

get full use of these data, a need exists for a means of quickly and accurately analyzing and displaying up-to-date site-specific tornado statistics. A PC software package to interactively perform such site specific hazard estimates is desired. The software output should include local or regional maps of tornado tracks (sorted by intensity), graphs of temporal and spacial distributions of past tornado events around the point of interest, and hazard estimates in terms of probabilities or reoccurrence intervals.

8.1.3A SUBTOPIC: Laser for an Unattended Atmospheric Water Vapor Profiler

The NOAA Environmental Technology Laboratory is currently building a compact, low-cost and eye-safe Differential Absorption Lidar (DIAL) to measure water vapor profiles in the lower troposphere with moderate spatial and temporal resolution. Such measurements are needed for the improvement of weather forecast and climate models. A low-cost, low-maintenance lidar system is desirable because it permits affordable unattended deployment of multiple lidars for regional studies of moisture transport (fluxes). The current lidar design uses a high pulse repetition frequency (prf) amplified diode laser with a maximum average power output of ~10 mW. Water vapor measurements with greatly improved time resolution and signal-to-noise ratio could be obtained with a 10 to 30 times more powerful laser. Proposals are desired for a higher power infrared solid state laser for the DIAL transmitter with the following capabilities. The laser should have a prf of 6-10 kHz, pulse durations of 20 to 200 ns, no prepulse light, a TEM00 mode, and good efficiency and stability. For DIAL, it is essential the laser can be locked to a specific wavelength with single frequency operation (a line width of several hundred MHZ). For the water vapor DIAL, the laser should be quickly tunable on and off one or more good water vapor lines in one of the following wavelength regions: 716-735 nm, 692-703 nm, 811-837 nm, or 892-986 nm.

8.1.4A SUBTOPIC: Automated Airborne Measurements of Atmospheric Chemical Species

The NOAA Office of Global Programs has broad interest in the measurement of atmospheric chemical composition variables for use in Federal and private sector Climate and Global Change (C&GC) studies. A network of surface-based chemical composition measurements exists, and there is a fledgling capability to observe selected chemical species globally by satellite, but the space/time resolution of these systems is too poor and the error bars of the satellite measurements are still too large. Examples of measurements needed include greater time/space scale coverage of atmospheric aerosols and atmospheric chemical composition (methane, ozone, carbon dioxide) profiles. Commercial aircraft have been identified as promising platforms for making global measurements to complement in-situ data and help continuously

calibrate satellite data over the four dimensions of space and time. Proposals are sought that suggest innovative approaches to the adaptation of proven automated, chemical composition species measurement techniques for use on such aircraft. Systems should provide accurate measurements of one or more of the variables listed above. In preparing proposals, investigators must remember that commercial aircraft require extremely small sensors, because space and weight are at a premium; therefore, only proposals that take this requirement into account should be submitted.

8.1.5A SUBTOPIC: Ultraviolet Laser Source for an Unattended Ozone Lidar

The NOAA Environmental Technology Laboratory has developed lidar systems for measurement of tropospheric ozone and is applying them to studies on urban and regional pollution. These systems are ultraviolet differential absorption lidars being used in ground-based and airborne applications. However, both require significant operator involvement and are physically large. In order to make this type of system more widely useful and less expensive to deploy, it would be desirable to build compact, high-reliability, unattended units. These units could then be set up in and around the pollution areas of interest for longer term monitoring, or more easily integrated into an airborne platform. To this end, we are seeking innovative developments in ultraviolet laser sources that could be applied to these systems. The general nature of the lasers sought may be compared to the diode pumped solid state lasers currently available for other wavelengths. The laser wavelengths needed for this type of lidar are in the 260-360 nm range. A minimum of two wavelengths are needed in the lower half of this range, with it being highly desirable to have one additional line near the upper end of the range. A rapidly tunable laser or several discrete operating lines would be preferred over having multiple sources. The laser output power should be in the 100 mW range or higher. Higher pulse energies are needed at shorter wavelengths than at longer wavelengths due to absorption by the atmospheric ozone. Short pulse durations of 20 to 200 ns and high pulse repetition rates would allow more flexibility in the lidar applications.

8.1.6A SUBTOPIC: A Directional Scanning Spectral Sky Radiance Mapper

One of the perplexing uncertainties facing atmospheric radiation research scientists today is the spatial distribution of atmospheric solar radiance, ranging from the UV through the near infrared. A very serious debate that has gained scientific attention is

the disparity between clear-sky theoretical calculations of solar transmission and what is observed. The range of the differences is approximately 30 to 50 W/m2. Although the solar and terrestrial radiation bands are somewhat separate, the solar irradiance difference by far exceeds the amount of change in IR irradiance expected to occur from trace gas warming. The solar transmission models do not explicitly calculate the sky radiance and, therefore, may be a source of uncertainty in the theoretical calculations. There exist sophisticated theoretical models that do explicitly calculate the sky radiance, but measurements for confirmation are rare, and for the most part, non-existent in various field investigations.

A secondary problem that the UV community has been struggling with is the determination of the error in the calibration of UV instruments. All hemispheric irradiance collectors suffer from what is called cosine error. If this error is not taken into account when using UV spectral radiometers, it propagates into the calibration of field instruments. The solution to this problem is the application of sky radiance measurements to correct for the irradiance collector's cosine error during a calibration episode. So far, we have identified a UV cosine error in the Brewer spectral irradiance as large as 7% which is intolerable (in some cases, it could be larger) since the standard lamp error is only on the order of < 2%, and this error is often misunderstood as the only instrumental error. Some instruments are much worse. With NOAA's responsibility as the Central UV Calibration Facility which characterizes and calibrates UV instruments in U.S. Government agency networks, it becomes obviously imperative that the best procedures be used.

The sky radiance mapper that would satisfy NOAA's needs should at least be able to supply maps of sky radiance in 10 wavelength bands (more would be desirable), in the UV and visible wavelengths (from ~0.3-2um, filters are O.K.) as a function of azimuth and elevation angle every 30 degrees in azimuth and elevation angle (the angular requirements should be selectable). The full viewing angle should be on the order of 1 degree. It would be desirable to acquire a complete scan of angle and irradiance in approximately three minutes or less. All parameters (e.g. time, angles, wavelengths, radiance, etc.) should be recorded on electronic media and the pointing of the instrument should be completely programmable and automated. One can expect a very large range of atmospheric radiance signal when viewing a clear sky compared to one with broken clouds, especially in the near IR. This range is also dependent on solar zenith angle, from high noon to near twilight, although practical considerations must be given, because physical requirements and instrument costs are indeed to be taken into account. A guess at the range is about 4 to 5 orders of magnitude.

The first phase should be a design study and a simple testing of components. The study should be focused on a practical compromise between the wavelength, range of sky radiances, solar zenith angle, and reasonable range of instrument sensitivity. It will be necessary to perform a brief study to determine the range of sky radiance conditions that can be expected.

A suggested reference is:

Blumthaler, J. Grobner, M. Huber, and W. Ambach. 1996. Measuring spectral and spatial variations of UVA and UVB sky radiance. Geophys. Res. Lett., vol 23, 547-550.

8.1.7A SUBTOPIC: Rotating Arm Attachment for Standard Pyranometers

Understanding the effect of clouds on the surface radiative energy budget is of critical importance in forecast model and satellite retrieval algorithm development. Techniques have been developed that use measurements of diffuse and total hemispheric solar (shortwave) irradiance to determine the cloud effect on the downwelling solar irradiance. However, current tracking-based systems for component solar measurements generally require periodic adjustment and maintenance, precluding deployment in remote locations. These tracker systems are also relatively expensive, thus deployment is also limited by economics. There are many sites, however, that already measure the downwelling solar irradiance using standard pyranometers (for example the Eppley model PSP). If an inexpensive rotating shading arm system can be attached to existing pyranometers, the solar components can be measured cost-effectively at these locations. This idea was investigated briefly at Penn State University with encouraging results. A rotating arm driven by a stepper motor was attached to an Eppley PSP. This system used the pyranometer response as the arm was rapidly moving through the upper hemisphere to "find" the sun and accurately position the arm, thus allowing the arm itself to be the minimum width required to block the pyranometer detector, and allowing error in system alignment (More information is available via the World Wide Web at http://www.srrb.noaa.gov/~long/publctns/publctns.htm). Due to the detector response time, a continuously rotating arm is not feasible for standard thermopile pyranometers, thus some type of arm positioning and holding system is necessary. Other systems have been developed that use faster responding silicone-based detectors (for example Licor pyranometers), which allows for constantly rotating arms. However, these detectors have different spectral ranges and responses from the standard thermopile pyranometers, and thus produce irradiance values different from the thermopile instruments under clear or cloudy skies (depending on how they were calibrated). The system developed at Penn State required a PC to run the arm and log the data, which increased the cost over what current technology could make possible. There are circuit

boards and data logging systems that are currently available and could be adapted to the task for far less cost. In addition, weather-hardened stepper motor and arm systems are available, such as those used for the Multi-Frequency Rotating Shadowband Radiometer developed at the State University of New York by Harrison and Michalsky. The innovation sought here is to integrate these commercially available parts to develop an inexpensive commercial rotating arm attachment system. Should an inexpensive rotating arm attachment for standard pyranometers as described above be developed, then cost-effective solar component measurements become feasible at far more sites than is currently possible, with the same spectral range and response as current standard instrumentation.

References:

Long, C. N. 1996. Surface Radiative Energy Budget and Cloud Forcing: Results from TOGA COARE and Techniques for Identifying and Calculating Clear Sky Irradiance. Doctoral Thesis, Penn State Univ., 193pp.

Long, C. N., C. F. Pavloski, and T. P. Ackerman 1996. A Rotating Shadow Arm Broadband Solar Radiometer: Instrument Design and Concept Verification Using ARM SGP Radiometer Measurements. Proc. 6th Atmospheric Radiation Measurement Science Team Meeting, Mar 4-7, 1996, San Antonio, Texas.

8.1.8A SUBTOPIC: X-Ray and Extreme Ultraviolet (EUV) Technologies for Solar Observations

Recent developments in solid state detectors for X-ray and EUV wavelengths have provided a technology from which light-weight, low-cost instruments for space-based observations have been built. These solid-state silicon diode detectors are extremely stable, and provide highly calibratable measurements for long periods of time. NOAA's Space Environment Center is starting to apply this technology to operational observations of X-ray and Extreme Ultraviolet emissions from the sun. These observations are used by SEC solar forecasters to identify the timing and magnitude of solar events and for estimating energy deposition in the upper atmosphere. Further refinements in detector technology, spectral dispersion, and spectrometric measurement techniques are desired. Specifically, methods of measuring the solar spectrum from 0.1 to 1000 Angstroms are required with moderate spectral resolution and over the large range of energies typically found in the solar spectrum. The instrumentation will also have to be robust, as it will be exposed to the radiation environment of geosynchronous orbit.

8.1.9A SUBTOPIC: Satellite Communications for Global Drifting Buoy Arrays

NOAA maintains a global array of low-cost drifting buoys for sea surface temperature, ocean current, atmospheric pressure and other meteorological observations. Data are used internationally for operational forecasts and model verifications. A variety of Low Earth Orbiting satellite (LEOs) constellations (NOAA/Argos, Orbcomm, Iridium, etc.) are now in, or will soon achieve, operational status. Potential benefits to be obtained from these new satellite systems include send and receive error-free communications, near real-time data transmissions, and reduced costs. Proposals are being sought for the identification of the most applicable LEOS system for drifter data communication, and subsequently for drifter construction and validation of data transmission. Data flow should include distribution onto the Global Telecommunications System (GTS). Emphasis should lie on the rapid, economic delivery of relatively short data records from low power transmitters. Existing drifter construction and operation are described in the World Meteorological Organization (WMO) Data Buoy Cooperation Panel (DBCP) Technical Document #4, available from the DBCP Technical Coordinator (email Etienne Charpentier at charpentier@cls.cnes.fr). A summary of existing and planned LEOS can be found in the report of the 12th DBCP meeting (October 1996) also available from the DBCP Technical Coordinator. Additional drifter information is available at the Global Drifter Center web site: http://www.aoml.noaa.gov/phod/dac/gdc.html.

8.2 NOAA TOPIC: OCEAN OBSERVATION SYSTEMS

8.2.1A SUBTOPIC: Operational Ocean Instrumentation, Measurement, and Data Assimilation Systems

Development of operational ocean instrumentation, measurement, and data assimilation systems are sought to support a wide range of NOAA 's National Ocean Service operational activities, such as current and water level measurement and prediction, wave forecasting, and marine pollution monitoring. These developments usually include all components of the entire monitoring system: sensing, data acquisition, and transmission. Data processing and analysis using innovative techniques will also be considered. The developments are not limited to any one type of platform (i.e., ship, towed system, buoy, airplane, satellite, etc.), and can be in-situ or remote, reusable or expendable. NOAA emphasizes systems which can be operated in an unattended mode. Where personnel are needed, use of only minimal skill levels is advantageous. If practical, these systems should provide near real-time data transmissions. Data transmissions via satellite and general purpose computer systems are used in NOAA to receive and process data. High reliability, known accuracy, and

cost effectiveness are important design considerations. The parameters of interest are comprehensive, including: physical, chemical, and biological properties of the coastal ocean environment; pollutants; and overlying atmospheric parameters. There is a special interest in parameters needed for the Coastal Ocean Forecast System (COFS). COFS provides marine environmental information in support of safe navigation, safe transportation of hazardous materials, economic benefits to marine commerce, and management of marine resources.

Of particular interest this year are proposals related to:

a) An alternative to the present NOAA primary water level sensor which uses an air acoustic transducer and sounding tube/protective well method. The sensor determines water level from the travel time of acoustic pulses to the water surface and return. There are several disadvantages associated with the tube/well subsystem. These include: the temperature gradient inside the well, marine fouling, attenuation of high frequency water level signals, and the high cost of installation and maintenance. NOAA is interested in investigating alternative, non-remote sensing technologies which do not require a sounding tube, such as laser, ultrasonic, or microwave ranging. The performance of the alternate sensor should improve upon the present accuracy of 9mm; resolution of 3 mm; range up to 10m; and sampling rate up to 4 samples per second.

b) Remote mapping of currents in the horizontal plane - Narrow-beam acoustic current profiler, or comparable technology, for remotely measuring the spatial current distribution in a horizontal plane near the mid-depth of a navigation waterway (harbors, bays, and river inlets) is sought. The sensor may be mounted on underwater structures such as piers, pilings, channel walls, or similar structures. The measurement should have a range of 400 meters (in water depth of 15 meters), and near-real time reporting capability. The ability to detect cross-channel velocity variations (flow deflections, current shears and eddies) is important.

c) Data Assimilation Systems - Algorithms and software for real-time objective analysis and gridding of data sets are needed for assimilation into hydrodynamic, numerical models for initialization, forcing, and evaluation of nowcasts and forecasts in coastal and estuarine models. The NOAA COFS system requires real-time realizations of surface meteorological and oceanographic fields for initialization, driving, and verification of their model nowcasts and forecasts of currents, water levels, temperature, and salinity. The data fields would need to be made available in a workstation or mainframe computer environment where the models would be running operationally.

8.2.2A SUBTOPIC: Hydrographic Data Acquisition and Data Processing

NOAA's National Ocean Service is seeking to improve the efficiency and effectiveness of its hydrographic operations. The request is for the development of software and algorithm solutions to problems of data acquisition and data processing. This does not, however, preclude solutions that are primarily hardware in nature. Of particular interest are: a) the blending of bathymetric data and acoustic imagery; b) improved data editing techniques which utilize both the acoustic backscatter strength and slant range time of flight on the several beams of a multibeam bathymetric sonar; c) efficient 3-D visualization of large fields of spatial data; and d) online tools for assessing/assigning quality parameters to bathymetric data as a function of nadir angle and natural variability of the local bathymetry.

8.2.3A SUBTOPIC: *In Situ* Chemical Analyzer

A requirement exists for developing *in situ* chemical analyzers that can be used to map or monitor chemical anomalies using continuous near real-time detection and data analysis. A system complete with chemical analyzer and data logger must be self contained so that it can be deployed by an underwater vehicle, mounted on a mooring, or used as a survey tool in concert with an underwater vehicle. This self-contained system should be developed for up to one-year deployments and have additional electronic ports for data from other sensors (e.g. temperature) to be synchronized with the chemical data. Problems associated with fouling and mineral precipitation should be considered.

8.2.4A SUBTOPIC: Improved Airborne Microwave Remote Sensing of Sea Surface Salinity

The proof-of-concept of airborne microwave sea surface salinity imaging measurements was successfully demonstrated in the mid-l990's with a low frequency microwave radiometer system operating in the 1.43GHz region. Using comparable systems relatively accurate surface salinity measurements have been obtained. Experience with these systems have suggested many improvements might be made which are achievable and affordable using the latest microwave technology advances. Better aerodynamics and reduced weight are needed to make an improved system deployable on a wide variety of small to medium size aircraft. These objectives could be achieved through improved packaging and utilization of newer antenna and antenna feed technologies. Improved calibration stability and reduced electrical requirements are very desirable, which might be achieved through an advanced thermal control subsystem. Improved thermal control and better aerodynamics are needed to allow the system to be deployed on higher altitude and faster (up to 300 knots) aircraft.

Improved system sensitivity and reduced receiver size could be achieved by using the latest low noise microwave amplifiers and low loss microwave control components. To improve sea surface salinity retrieval accuracy and to add sea surface temperature mapping as an ancillary capability, a scanning infrared sensor should be part of the system package. Other small-size, low cost auxiliary sensors are sought for deployment with the salinity mapper system to enhance its performance. These could include improved GPS receivers and aircraft pitch and yaw sensors. Software needs include: (1) improved salinity algorithms, (2) real time display of retrieved salinity and sea surface temperature using false-color images, and (3) improved user interface which might utilize WINDOWS GUL.

Reference:

Goodberlet, Mark, et al. Microwave Remote Sensing of Coastal Zone Salinity. Journal of Coastal Research, vol 13, no. 2, pp.363-372, Spring 1997.

8.3 NOAA TOPIC: LIVING MARINE RESOURCES

8.3.1A SUBTOPIC: Rapid, Sensitive, Non-Lethal Method for the Identification of Bacterial Pathogens of Salmonids

The objective is to develop a reliable, easy to use, field kit method for rapid, sensitive, and non-lethal identification of important bacterial pathogens of salmonids, such as bacterial kidney disease in various tissues, including blood, from suspect fish. At present, laboratory extraction of RNA and subsequent identification of bacterial species-specific DNA sequences by a combination of reverse transcription (RT), polymerase chain reaction (PCR) amplification of specific 16S ribosomal RNA, and molecular probing has proven to be a powerful technique. The intent of this subtopic is to further evaluate this concept and develop methods to automate the various steps to make it applicable for reliable field use. Such a field kit will be extremely useful for managers of various types of fish rearing facilities, including those charged with the cultivation and restoration of endangered species.

Reference:

Boddinghaus, B., T. Rogall, T. Flohr, H. Blocker, and E. C. Bottger. 1990. Detection and identification of Mycobacteria by amplification of rRNA. J. Clinical Microbiol, 28: 1751-1759.

8.3.2A SUBTOPIC: Automated Genetic Probe Field Assay for Toxic Algae

The objective is to develop and demonstrate the utility of an automated field test kit for toxic species of marine algae, which will enable the public and private sector to assess the presence of toxic algae in marine waters neighboring commercially and recreationally important shellfish areas. Economic losses due to algal toxins which are accumulated by shellfish include the costs of shellfish monitoring by state health officials; the reduction in sales of commercial fish, shellfish, and crab; the closure of many beaches to the recreational harvest of shellfish during summer months; lost tourist trade; human illness; and sometimes deaths.

Mouse bioassay, the method currently used by Washington State Department of Health for the quantification of toxin levels in commercial shellfish and crustaceans, is a time-consuming laboratory process using live animals. Such use of live animals in the field can be prohibitive and restrictive. Recently, ribosomal DNA has been sequenced and oligonucleotide probes which specifically recognize toxic species of algae have been synthesized (Scholin et. al., 1996; Miller and Scholin, 1996). In theory, the use of these specific DNA probes in conjunction with field processing of seawater will allow real-time estimations of the number and types of toxic algae in a given sample. This on-site "dipstick" test would allow state health officials, native Americans who depend on shellfish for their livelihood, and shellfish fisheries to quickly and efficiently process seawater samples, thereby enabling them to independently quantify toxic marine algal species in areas of commercial and recreational interest.

References:

Scholin, C.A., K.R. Buck, T. Britschgi, G. Cangelosi, and F.P. Chavez. 1996. Identification of Pseudo-nitzschia australis (Bacillariophyceae) using rRNA- targeted probes in whole cell and sandwich hybridization formats. Phycologia 35(3), 190-197.

Miller, P.E. and C.A. Scholin. 1996. Identification of cultured Pseudo-nitzschia (Bacillariophyceae) using species-specific LSU rRNA-targeted fluorescent probes. J. Phycol. 32, 646-655.

8.3.3A SUBTOPIC: Three Dimensional Fish Tracking

The objective is to develop and demonstrate hardware and software for high resolution tracking and determination of position, in three dimensional space, of fish equipped with transponding acoustic tags. Although the quality of range and positioning data will vary with the tag used and with environmental conditions, the maximum reliable range of the system should be at least 150m. One approach to high resolution determination of

range and location of a transponding acoustic tag is triangulation by an array of underwater transducers, using the delay after interrogation of a tag that its signal is returned to the interrogating transducer, and the relative arrival time of the transponded signal at each transducer in the array. Incremental measurements of position will determine the path of a tagged fish in three dimensional space. The intent of this research is to develop a quantitative method to determine the behavior of fish in proximity to structures such as dams and surface collectors as part of an overall attempt to improve the passage survival of fish.

8.4 NOAA TOPIC: OCEAN SCIENCE

8.4.1SG SUBTOPIC: Aquaculture: Water Reuse and Effluent Treatment Systems

Proposals are requested for developing integrated aquaculture systems with minimum impact on the environment. These include development of innovative water reuse systems for ponds and raceways and other novel systems for treating effluent. Special priority will be given to prototype, modular water reuse systems suitable for producing a variety of species anywhere in the United States.

8.4.2SG SUBTOPIC: Aquaculture: Developing and Improving Marine Species Culture

Proposals are requested for research which offers to make significant, industry-wide improvements in marine finfish, shellfish, and marine ornamental fish culture systems for both small scale and large scale applications. Priority will be given to research which finds innovative approaches which will solve major industry bottlenecks in an economically and environmentally compatible manner. Research aimed at new marine species for culture and research to adapt techniques being used successfully in other countries are appropriate.

8.4.3SG SUBTOPIC: Open-Ocean Aquaculture Systems

Both engineering and biological technology needs to be explored for the development of open-ocean or offshore culture systems. Large scale, offshore, submersible, and floating systems need to be developed for Atlantic, Gulf of Mexico, and Pacific conditions. Automation of feeding and harvesting functions as well as telemetry and remote control systems will be considered in this competition. The biological technology

would include hatchery, nursery and transport systems for candidate species for open ocean-aquaculture. Field tests of candidate species are encouraged.

8.4.4SG SUBTOPIC: Value-Added Products for Seafood

The development of value-added products for seafood, including seaweed, is urgently needed to expand the markets of these products. Projects on new processing equipment and techniques, new product forms, international market formats, and the use of underutilized species are appropriate for this topic. Special emphasis will go to products developed from waste streams in established seafood processing activities.

8.4.5SG SUBTOPIC: Sensor Technologies for Measuring & Detecting Microbiota in the Water

Proposals are requested for probes and/or automated sensor technology, for the detection and quantification of specific microbial and environmental water problems, most notably characterization of species-specific identification and detection of human, fish, and shellfish pathogens.

8.4.6SG SUBTOPIC: Alternative Technologies to Ballast WaterExchange

The problem of nonindigenous species invasions is a growing concern in both Great Lakes and marine coastal waters. Many of these invasions occur through release of ballast water, but other than mid ocean ballast water exchange, often a time-consuming and occasionally risky process, there is no effective method of eliminating this pathway for introductions. Research is needed to develop efficient and cost-effective alternative technologies to ballast water exchange for the shipping industry so that mid-ocean exchange of ballast water may be avoided and the risk of introductions reduced.

8.4.7A SUBTOPIC: A Microbial Sampler for Deep-sea Research and Discovery

The microbial diversity at deep-sea hydrothermal vents is poorly studied and yet represents some of the richest potential for basic science as well as for applied biotechnological applications. This lack of knowledge is largely due to limitations in the methodologies for studying microbial diversity but also in part due to the difficulty in obtaining discreet, defined, and reliable microbiological samples. This capability is needed by microbial biologists and biotechnologists interested in sampling deep-sea vents. Some of the features that are required for effective collection of deep-sea microbial biomass, but currently not available, are: (1) a simple sampler that is easily

operated by both submersibles and remotely operated vehicles;(2) that maintains the sample uncontaminated, both during sampling and during retrieval shipboard; (3) that allows multiple sample application, such as core samples, filtered samples; (4) that are pumped, etc.; (5) that takes associated critical physical measurements such as temperature; (6) that allows for microbial activity measurements and/or enrichments to be made *in situ;* (7) that if required, can maintain the sample under pressure (pressures greater than 300 atm) during retrieval; and (8) that can allow for sample transferal under pressure to an isolation chamber.

Such a sampler does not exist, and would greatly enhance our understanding of the microbial ecology of deep-sea vents. Furthermore, with the current heightened interest in the biotechnological application of extremophiles, there is an interest in this community to obtain uncontaminated samples from the deep-sea. Stimulating the development of such a sampler may also attract the attention of sampling devices that need to be developed for uncontaminated sampling on other planets during space missions.

8.4.8A SUBTOPIC: A ROV Mounted Sensor System for Mapping the Distribution of Benthic Microalgae

A sensor system is needed to map the fine scale distribution of microalgae growing on the surface of seafloor sediments. Typically, sediment sampling is required to collect such data; which inherently has lower spatial resolution and is time consuming to process. Initial use of such a sensor would be from an remotely operated vehicle (ROV) platform, but such a system could be mounted to a sled with conducting tow line/wire for wider use in the oceanographic community. We envision an approach which takes advantage of the florescence characteristics of chlorophyll-a, using excitation light filtered through a narrow-band filter. There are several required characteristics for such a system. First is the need for a source of blue light (436 nm). Currently, there are no blue light lasers adequate for this kind of system, so a source which produces a range of light wavelengths around that wavelength and a narrow band filter will be needed. More problematic is the need to sense red (680 nm) florescence coming back at the sensor. Water rapidly attenuates light at 680 nm. Suspended particulates and dissolved organics also affect attenuation and scattering. Self calibration for characteristics of near-bottom water will most likely be needed to determine true emission intensity. Calculations of sensitivity of such a system are needed to assess the validity of data which could be acquired. A feasibility study is needed to determine the capabilities of such a sensor system based on physical constraints, technological limitations, and sensitivity of the sensor.

8.4.9A SUBTOPIC: Improvements to NOAA Airborne Research Radiometers

The NOAA Airborne Water Substance Microwave Radiometer (AWSMR) has proven to be a versatile instrument. In its upward-looking mode, it measures the precipitable water vapor and integrated cloud liquid. In its downward-looking mode, the AWSMR has been used to measure the wind speed and direction near the ocean surface, and to measure oceanic internal waves. Recently, the AWSMR was modified to be capable of scanning a swath of the ocean surface. A new usage for the system is to measure the thickness and extent of surface oil slicks, both natural and accidental. The sensitivity of the current AWSMR is 0.06 K with an accuracy of 0.2 K for a one second integration time. Microwave technology has advanced over recent years making it possible for the AWSMR to be made more compact, to increase the sensitivity of its measurements, and to improve its reliability at all operational altitudes. NOAA is therefore soliciting proposals to convert a ground-based water substance microwave radiometer into a second airborne version utilizing the recent advances in technology. A second task would be to streamline and modernize the current AWSMR.

8.4.10A SUBTOPIC: Polarimetric Infrared Imager

NOAA's Environmental Technology Laboratory is interested in using polarimetric infrared imaging for environmental remote sensing, especially of the ocean surface. Therefore, this subtopic is for development of a polarimetric infrared imaging system operating in a wavelength range of nominally 8–12 μm for use in demanding field environments. Desirable features include small size and weight, capability of maintaining a radiometric calibration to the order of 1%, operation without cryogens, and rugged design. The technology should be capable of characterizing the state of polarization of each pixel in a near-ambient-temperature (~300K) thermal infrared scene from a moving platform, with 1% radiometric and polarimetric accuracy.

8.5 NOAA TOPIC: CARTOGRAPHY AND INFORMATION SYSTEMS

8.5.1A SUBTOPIC: Cartographic Data and Geographic Information Systems (GIS)

Innovations with commercial potential are sought incorporating new and emerging technologies related to digital cartographic and GIS systems to support National Ocean Service (NOS) requirements. The NOS makes its products, data, and metadata available to agencies, academia and the public through electronic access via computer networks. Needed research critical to the NOS mission includes:

- Heads-up raster and vector navigation and nautical charting data shown in 2 and 3 dimensional displays for mariners. Such practical information could be shown on semi-transparent, portable, heads-up displays superimposed in novel ways on the actual environment to help mariners navigate, especially in conditions of limited visibility.

- A comprehensive method for remote real-time monitoring of navigation channel depths to within 1 foot and widths to within 10 feet throughout the entire channel length (1 mile to 100 miles). The method must be comparable in cost to the periodic sonar surveys currently in use. A survey by this method should require 24 hours or less, if possible.

- New methods for generation, update, and transfer of geodata products and data files from spatial data bases, including raster images, to meet emerging requirements of Electronic Chart Display and Information System (ECDIS) and similar shipboard electronic navigation systems using raster displays.

- User-transparent approaches to geodata and geoprocessing interoperability across networks (e.g., the Internet), for:
  - Software Interoperability: Automatically invoked platform independent processing functions,
  - Data Interoperability: User-transparent autonomous standard file format conversions.
- Innovations for easily locating, accessing, searching, transferring, reformatting, and portraying geodata and GIS graphic products across networks. These could involve knowledge processing via expert systems and/or neural nets, hyperlinks (e.g., Netscape-like), geospatial search engines, or improved conventional techniques.

- New methods for enhancing/compressing raster images of nautical chart features, including text and feature symbology. These can range from conventional image processing and optical character recognition algorithms to the use of expert systems, fuzzy logic, neural nets, and specialized pattern recognition/matching algorithms.

- Improved methods for error-free raster-to-vector and vector-to-raster conversion/compression for digital raster images, including semi-automated GIS data attribution and metadata generation directly from the vectorized raster data files.

8.5.2SG SUBTOPIC: Recreational Boat Charting

Recreational boating is a high growth industry and an important component to the economy. Navigational charts are critical to creating safe boating through presentation of traditional piloting and navigation data. However, new techniques make it feasible to include historical and resource management information on charts to give boaters an understanding of the environmental conditions in given areas. Research is needed to (1) Design and test a suitable field methodology utilizing DGPS/GIS/GIS technology; (2) Determine optimal map scale and resolution for recreational boat users; (3) Adapt remote sensing and GIS technologies to photomap product development.

8.5.3A SUBTOPIC: Metadata Creation, Validation, and Management Systems

Proposals related to the development of a Metadata Administrative Tool (MAT) for the creation, validation and management of metadata records in accordance with the Federal Geospatial Data Committee (FGDC) metadata standard. The intent is to create an off the shelf tool to assist the user in dealing with these metadata issues.

The creation of the World Wide Web (WWW), along with Executive Order #12906 have put an extreme burden on Federal agencies in the area of metadata. Agencies are required to create comprehensive metadata records which describe extent, spatial & temporal coverage, quality of record, etc. for each data set they hold. There are currently no adequate software packages available to support this activity, forcing each office or center to create custom code to deal with this complex problem. The result is a mixed bag, with each tool supporting a single aspect of metadata management, achieving varying degrees of success. All of the tools are provided as shareware with minimal documentation, reliability, and support. This often leads to each individual metadata provider creating their own system rather than facing the daunting task of incorporating changes to preexisting programs. What is required is a single tool that can handle all aspects of metadata management and meets the specific requirements below. A review of all known tools is available from http://www.fgdc.gov:80/Metadata/Mitre/task2/index.html .

The tool developed will have broad commercial potential. With the advent of the WWW, the ability to search a distributed archive(s) has been greatly enhanced. Programs such as NOAAServer, MEL, ECSInfo all rely on complete and accurate metadata records while providing no tools to those who are required to create the records. In the non-governmental area, data sellers, such as GIS providers, satellite operators, map makers, etc. could each benefit from such a tool by enhancing their visibility and

accessibility through the WWW. Finally in the retail area the potential is virtually unlimited. By combining customizable data dictionaries with metadata the system would allow an on-line provider to create metadata that is visible globally in multiple languages, thereby reaching into new markets.

Requirements desirable in the developed tool are listed below.

Flexibility in Defining Metadata:
* Provides the ability to create and customize locally defined metadata elements, where the elements may be arbitrarily hierarchical and/or repeating.
* Provides support for standard and custom data dictionaries of controlled vocabulary terms.
* Supports multiple data types for metadata elements (e.g., latitude, floating numbers, memos, dates, etc).
* Specification of elements as optional and with default values.

Ease of Use:
* Provides an easy-to-use graphical user interface.
* Provides data filters for narrowing the selection of data records being viewed to a specified subset based on element criteria.
* Allows user to enter data directly into the system.
* Verifies entered data is in compliance with standards requirements.
* Includes on-line context sensitive help.
* Supports multiple, independent databases of metadata elements.
* Tool must interface to search engines through the Z39.50 specification to permit easy and efficient data interaction with Intranet/Internet.
* Supports metadata imports and exports in standard file formats.
* Supports customizable metadata file import/export for use with user specific metadata.
* Provides programming interfaces for the development for custom imports and exports (e.g., import and exports directly to/from databases).
* Verifies imported metadata prior to inserting data in database (e.g.,the import complies with a standards requirements).
* Supports user configurable mapping between import/export data elements and metadata elements.
* Access clients available from multiple platforms, preferably through a web browser.

Database Connectivity:
* Uses relational database to store and retrieve the metadata via the Open Database Connectivity (ODBC) standard.
* Able to retrieve metadata field updates through the ODBC interface from existing databases.

Standards Compliance:
* Enforces mandatory, optional and mandatory if applicable, aspects of standards (e.g., as specified by FGDC standard).
* Includes predefined, online metadata standard definitions for each core element, including description, usage guidelines, and examples.
* Includes dictionaries of predefined controlled elements as defined by standards.